Parametric Valid Inequalities in Discrete Optimization

Suresh Bolusani[1]
Ph.D. Advisor: Ted K. Ralphs[1]

[1]COR@L Lab, Department of Industrial and Systems Engineering, Lehigh University

Parametric Valid Inequalities

- Developed parametric valid inequalities (PVIs) based on duality and the value functions of multilevel/multistage mixed integer linear optimization problems
- Employed these inequalities in two research works

Solving Multilevel/Multistage Mixed Integer Linear Optimization

Motivation

Many real-world applications have:

- Discrete/indivisible decisions
- Multiple objectives
- Multiple decision-makers
- Multiple time periods

But hardly any research work addresses this generic class of problems

Application Areas

- Airline pricing and capacity allocation
- Natural gas shipping
- Road network construction
- Toll revenue maximization
- Electricity demand management
- Chemical process optimization
- Gene-deletion strategy development
- Attacker-defender type problems
- Many more...

Methodology

- Developed an abstract framework for generalizing Benders' technique for reformulation that encompasses non-traditional problem classes
- Specified an algorithmic procedure employing PVIs
- Applied this procedure to solve mixed integer bilevel linear optimization problems
- Implemented this algorithm in MibS, an open-source solver written in C++

Warm-starting Mixed Integer Linear Optimization

Motivation

Many applications require re-solving an optimization problem:

- Thousands of times per minute
- Closely-related problems with minor variation in the input data

But usually, these re-solves are done independently by discarding most of the useful historical information

Application Areas

Online optimization

- Routing
- Stochastic matching
- Resource allocation

Optimization problem classes

- Bilevel optimization
- Multi-criteria optimization
- Stochastic optimization

Algorithms

- Decomposition
- Lagrangian relaxation

Methodology

- Solving an optimization problem
- Gathering relevant information primarily based on the theory of duality
- Reusing above information for solving another problem by using PVIs
- Implementation in SYMPHONY, an open-source solver written in C/C++